ISSN 1875-3728, Geography and Natural Resources, 2018, Vol. 39, No. 3, pp. 204-211. © Pleiades Publishing, Ltd., 2018.
Original Russian Text © R.A. Medvedeva, V.N. Golosov, O.P. Ermolaev, 2018, published in Geografiya i Prirodnye Resursy, 2018, Vol. 39, No. 3, pp. 29-37.

ENVIRONMENTAL PROTECTION

Spatio-Temporal Assessment of Gully Erosion in the Zone of Intensive Agriculture in the European Part of Russia

R. A. Medvedeva [a, *], V. N. Golosov [a, b, **] and O. P. Ermolaev [a, *]**

[a] *Kazan (Volga Region) Federal University, 420008, Kazan, ul. Kremlevskaya, 18, Russia*

[b] *Lomonosov Moscow State University, Moscow, 119991 Russia*

** e-mail: gregina8@mail.ru*

*** e-mail: golossov@gmail.com*

**** e-mail: oyermol@gmail.com*

Received August 10, 2017

Abstract—Using the method of mapping by high resolution satellite imagery mapping, a study was made of the key areas which are located in the southern part of the forest, forest-steppe and steppe zones of Tatarstan and of Orenburg, Saratov and Voronezh oblasts. Two key indicators were determined: the gully length density and gully head density within the basins; results of the investigation were used in compiling respective maps in vector format. It is established that the density of the gully length in the basins varies over the range from 0 to 0.5 km/km^2 (from the absence of gullies to strong gully erosion), and the density of gully heads from 0 to 3 units/km^2. The slope type of gullies is dominant in all basins (about 80%), while the coastal and bottom types have approximately the same proportion (14 and 10%, respectively). Using methods of mathematical statistics we determined a high directly proportional dependence of the indicators of the contemporary gully network on the level of ploughness of the basins and the mean annual precipitation amount, and an indirectly proportional dependence on the level of sodding. An abrupt reduction in gullying indicators was determined. It was found that among the chief reasons behind an abrupt reduction in the gullies to date is a decrease of the rate of agricultural development, with an additional factor, namely, a dramatic decrease in surface runoff down the arable slopes during spring snowmelt caused by climate warming. It is concluded that that a significant part of the gully forms in the study area is currently inactive and massively passes into the balka stage.

DOI: 10.1134/S1875372818030034

Keywords: basins, satellite imagery interpretation, gully length and gully head density, dynamics.

INTRODUCTION

Gully erosion is one of the crucial relief-forming processes. Negative consequences of gullying are, to the highest degree, manifested in the degradation of agricultural lands as well as in destruction of engineering facilities and utility systems. Mapping of the spatial development of contemporary gullies was assessed in a large region of Asian Russia, in the south of Eastern Siberia [1, 2]. For the last thirty years, however, there have been almost no scientific generalizations concerning the rates of gully erosion in the most developed agricultural areas of the southern half of the European territory of Russia (ETR). Meanwhile, this time interval saw a number of drastic changes, on the one hand, in the climatic system and, on the other, in land-use practices. Furthermore, high and very high resolution satellite imagery began to be publicly available in the 2000s and onward, which compared well in their quality with large-scale aerial photographs, coupled with the tools of methods to analyze them. All this dictates a highly relevant need for investigations seeking to determine the dynamics of contemporary gully erosion on the ETR's agricultural lands.

The goal of this study was to make a spatio-temporal assessment of gully erosion in the zone of intensive agriculture on the European territory of Russia. The spectrum of the objectives to be achieved included selecting the key areas, interpreting high resolution satellite imagery for determining the main quantitative indicators characterizing the gully density of the territory, namely, the length and head density of the gully network, as well as for ascertaining the development trend of contemporary gullies.

Earth remote sensing (ERS) data provide a powerful tool for mapping the gully dissection of territories. As early as half a century ago, much attention was given to interpretation of aerial photographs and field mapping when assessing the spatial development of gullies and its dynamics [3–4]. The advent of publicly available high and very high resolution satellite imagery has now opened up brand new vistas for its processing and analysis in order to identify the gully erosion processes [5–8].